Executive Summary

Software Defined Infrastructure (SDI) primarily defines IT infrastructure managed by software to deliver unprecedented agility and responsiveness to business.

Transitioning to SDI is a long-term process, but Network Virtualization Overlays (NVO) such as VMware* NSX, are available today and can provide important abstraction and virtualization functions to support Software Defined Networking (SDN), a core component of SDI.

Moving to NVO delivers many benefits, including faster network and application provisioning times, faster recovery times during disasters and better security inside the data center. But, sometimes network performance can be impacted by the network virtualization layer.

Many have attempted to achieve a full 10GbE network, but have failed. This paper shows, through several use cases, how running NSX on newer hardware results in noticeably better network performance. Achieving near 10GbE network performance is both feasible and beneficial using the Intel® Xeon® processor E5-2699 v4 and VMware NSX.
Introduction

The move to Software Defined Infrastructure (SDI) is ongoing for most industries today. Server virtualization is essential in most data center implementations, but this places demand on traditional network infrastructure implementations. Given this increased demand, implementing a Software Defined Networking (SDN) solution makes sense to tackle the challenges of virtual machines. Many companies have employed virtual LANs as a way to compensate, but vLANS present their own challenges.

IT Challenges with vLANT Networking

Traditional vLAN architectures can have many issues: flooding, spanning tree, physical limit, and single broadcast (and failure) domain. Solutions have evolved to patch vLAN gaps, but they can’t sustain modern distributed workloads.

Enterprise service delivery remains slow, limited and error prone. Configuration is box-by-box for a multitude of vLANs, firewall rules, load balancers, ACL, QoS, VRF and MAC/IP tables.

All in all—there must be a better answer, and there is: Network Virtualization Overlays.

What Is a Network Virtualization Overlay?

At its most basic level, a Network Virtualization Overlay (NVO) creates an abstraction layer on top of the physical network allowing for more secure, efficient communication between VMs (see Figure 1). The network communication between virtual hosts may be virtualized, but the physical transport requirements remain an essential component of a successful virtual network implementation. To be effective, the NVO should:

- Support the logical segmentation of LANs in a manner that provides equivalent or more effective network segment isolation, including tenant traffic and address space isolation between each tenant, and overlay network address space isolation from tenant address space.
- Support a significantly higher number of virtual LAN segments.
- Function within the Ethernet and IP network construct for implementation in existing environments.
- Promote a scalable, flexible and manageable network infrastructure, capable of providing the network throughput required.
- Be fully standardized as a protocol to support hardware and software vendor interoperability.
- Support implementation in hardware for efficient packet processing and potential participation with the encapsulation protocol being implemented. Virtualization may abstract specific hardware and software interactions, but it does not remove dependence on underlying hardware to support compute, store and transmit functions.

Benefits of Network Virtualization Overlays

The biggest overall advantage of using an NVO is the ability to model your physical networking environment using software.

NVO solutions like VMware NSX reduce the complexity of today’s physical networks, and application and network provisioning times. Network administrators manage network services from a central management tool. The ability to easily scale your network reduces overall capital and operational expenditures.

According to research, the most common benefits of deploying software defined networking are cost-savings over traditional networking approaches, and improved network performance (see Figure 2).

Why VMware NSX for NVO?

IT organizations have gained significant benefits as a direct result of server virtualization. Tangible advantages of server consolidation include reduced physical complexity, increased operational efficiency and simplified dynamic repurposing of underlying resources.

VMware’s Software Defined Data Center (SDDC) architecture moves beyond the server, extending virtualization technologies across the entire physical data center infrastructure. VMware NSX, the network virtualization platform, is a key product in the SDDC architecture. With VMware NSX, virtualization now delivers for networking what it has already delivered for compute, helping IT to quickly and optimally meet the needs of increasingly dynamic business.
Traditional server virtualization programmatically creates, snapshots, deletes and restores virtual machines (VMs); similarly, network virtualization with VMware NSX programmatically creates, snapshots, deletes and restores software-based virtual networks.

VMware NSX reproduces the complete set of Layer 2 to Layer 7 networking services in software (e.g., switching, routing, access control, firewalls, quality of service (QoS) and load balancing).

The result is a completely transformative approach to networking, enabling orders of magnitude better agility and economics while vastly simplifying the operational model for the underlying physical network. This completely non-disruptive solution can be deployed on any IP network from any vendor – for traditional networking models and next generation fabric architectures. The physical network infrastructure already in place is all that is required to deploy a software-defined data center with VMware NSX.

**Intel Technologies for NVO**

Intel has been implementing various acceleration technologies for Network Virtualization Overlays since 2011. These technologies can have a significant impact on the distribution of NVO-related compute overhead between processor and network adapter resources, as well as the network throughput realized.¹

The Intel® Xeon® processor E5 family delivers performance and efficiency across the widest range of workloads, with an array of new technologies for more efficient virtualization, smarter resource orchestration and enhanced protection of systems and data. The Intel Xeon processor E5-2600 v4 product family can help businesses, cloud service providers and telecommunications companies get higher performance and value from every new server, while accelerating their move toward the next-generation efficiencies of Software Defined Infrastructure.⁵

**Network Performance with VMware NSX**

A common perception that some testing results support, is the notion that adding VMware NSX, or any other NVO solution, greatly impacts network performance. However, this is not the case.⁶

It is possible to achieve the full potential of your 10GbE network and still run VMware NSX with little to no impact to performance when you:

- Use a server that has an Intel Xeon processor E5-2699 v4
- Reimage VMs

Both Netperf results (see Figure 3) and iPerf results (see Figure 4) show negligible performance differences, with or without NSX, when using the Intel Xeon processor E5-2699 v4 with reimaged VMs.

![Figure 3. NetPerf results for Intel® Xeon® processor E5-2620 v2 and E5-2699 v4, with and without NSX and reimaged VMs.](image)

![Figure 4. iPerf results for Intel® Xeon® processor E5-2620 v2 and E5-2699 v4, with and without NSX and reimaged VMs.](image)
Testing Methodologies

For performance testing, Netperf and iPerf were chosen as readily available open source tools that are widely used for throughput testing. It was found in the iPerf testing that two simultaneous sessions provided near the maximum throughput. With this in mind, two Netperf client sessions were run simultaneously and the throughput for the sessions were added together to provide the full throughput.

A 60-second time was used as the default time for test runs to minimize small spikes in performance.

A socket and message size of 128 Kbytes was used to provide an equal comparison to the iPerf results while still providing the maximum throughput results.

Testing Equipment, Architecture and Configuration

Several use cases were performed to test network performance using older and newer processors, with and without NSX, and with reimaging VMs.

Baseline Equipment Architecture

Figure 5 shows the architecture used for both Use Case 1 and Use Case 2. The ESXi hosts at the bottom are connected to vSphere Distributed Switches (VDS) that are single homed to two Cisco Nexus 9396PX switches using 10 Gbps Intel® Ethernet Converged Network Adapter X710. Traffic between the ESXi hosts use the 40 Gbps ACI fabric.

Use Case 1: Older hardware without NSX

Baseline architecture using VMware ESXi hosts based on Intel® Xeon® processor E5-2620 v2 (2.10 GHz) using 10 GbE interfaces without VMware NSX

• Utilize ESXi hosts connected to a spine/leaf architecture
• 10GbE Intel Ethernet Converged Network Adapter X710
• Configure one CentOS 7 VM on each host for testing
• VMs connected using VMware vSphere*

The architecture used during testing utilized Cisco ACI with a VMware NSX overlay for network connectivity. This provided ESXi hosts connected to the Cisco Nexus 9000 leaf switches via 10 Gbps fiber connections. The leaf switches were connected to the spine switches via 40 Gbps connections.

Use Case 2: Older hardware with NSX

Baseline architecture using VMware ESXi hosts based on Intel Xeon processor E5-2620 v2 (2.10 GHz) using 10 GbE interfaces with VMware NSX

• Utilize VMware NSX with ESXi hosts connected to a spine/leaf architecture
• 10GbE Intel Ethernet Converged Network Adapter X710
• Configure one CentOS 7 VM on each host for testing
• VMs connected using VMware vSphere*

The architecture during testing utilizes Cisco ACI with a VMware NSX overlay for network connectivity. This provided ESXi hosts connected to the Cisco Nexus 9000 leaf switches via 10 Gbps fiber connections. The leaf switches were connected to the spine switches via 40 Gbps connections.

Updated Equipment Architecture

Figure 6 shows the physical architecture and the IP addresses used during the testing for both Use Case 3 and Use Case 4.
**Use Case 3: New hardware without NSX**

Updated architecture using ESXi hosts based on Intel Xeon processor E5-2699 v4 (2.20GHz) using 10 GbE interface without NSX

- Utilize two ESXi hosts connected to a single 10 GbE switch
- 10GbE Intel® Ethernet Converged Network Adapter X710
- Configure one CentOS 7 VM on each host for testing
- VMs connected using VMware vSphere*

This use case was completed using servers with 10GbE Intel Ethernet Converged Network Adapter X710 connected to a single Extreme Summit* X650 switch. The servers were dedicated to the testing and did not have other virtual machines present.

In this test, the VDS was modified to have an MTU size of 9000 bytes to provide the highest throughput. The VMs had their MTU set to 8900 to take into account the additional VXLAN header.

There were issues connecting to the virtual machines through the network so console access was used for the test. Because all testing was done on a single subnet, there was no impact to the test results.

**Use Case 4: New hardware with NSX with offloading enabled**

Updated architecture using ESXi hosts based on Intel Xeon processor E5-2699 v4 (2.20GHz) using 10 GbE interface with NSX

- Utilize two ESXi hosts connected to a single 10 GbE switch
- 10GbE Intel® Ethernet Converged Network Adapter X710
- Configure one CentOS 7 VM on each host for testing
- VMs connected using VMware vSphere*

VMware NSX was used as the overlay to provide data showing the impact of the VXLAN encapsulation on the throughput.

It should be noted that two new equipment scenarios were tested on two different generations of the Intel Xeon processor E5-2699 for comparison—the older Intel Xeon processor E5-2699 v3 (2.30GHz) and the newer Intel Xeon processor E5-2699 v4 (2.20GHz).

The initial results using the Intel Xeon processor E5-2699 v4 included CentOS VMs used from the previous Intel Xeon processor E5-2699 v3 testing. Another round of testing of Use Cases 3 and 4 were completed using CentOS VMs built after the processor upgrade. The results of this testing are reflected in the analysis as entries with “Reimaged VMs” in the label.

Figure 6. Architecture for use cases 3 and 4.
Conclusion

Many businesses want the benefits of Software Defined Infrastructure, and particularly Software Defined Networking, but are concerned that adding Network Virtualization Overlays will impact network performance.

It is clear from testing that adding VMware NSX does not significantly impact network performance when using servers with an Intel Xeon processor E5-2699 v4. Additionally, reimaging your VMs might increase performance with or without NSX. While analysis shows that adding VMware NSX slightly degrades network performance, the small performance lags are more than offset by the benefits of Network Virtualization Overlays.

With the Intel Xeon processor E5-2699 v4 and VMware NSX, any customer can experience the benefits of 10 GbE networking as well as faster network provisioning, enhanced security and greater application continuity.

6. Results based on Intel internal analysis using configurations described herein.